

# Decommissioning of a Research Laboratory in New York State

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# Presentation Outline

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2. Decommissioning Plan
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4. On-Site Activities
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6. Final Status Survey Report
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# Facility Description

- New York State – NY Dept. of Labor Radioactive Materials License
- Research and development of pharmaceuticals
- H-3, C-14, P-32, Cl-36, and Cr-51
- Research laboratory (1) and Immunology Rooms (2)
  - Locations of spills
- Waste decay and storage room (1)
- Hallways

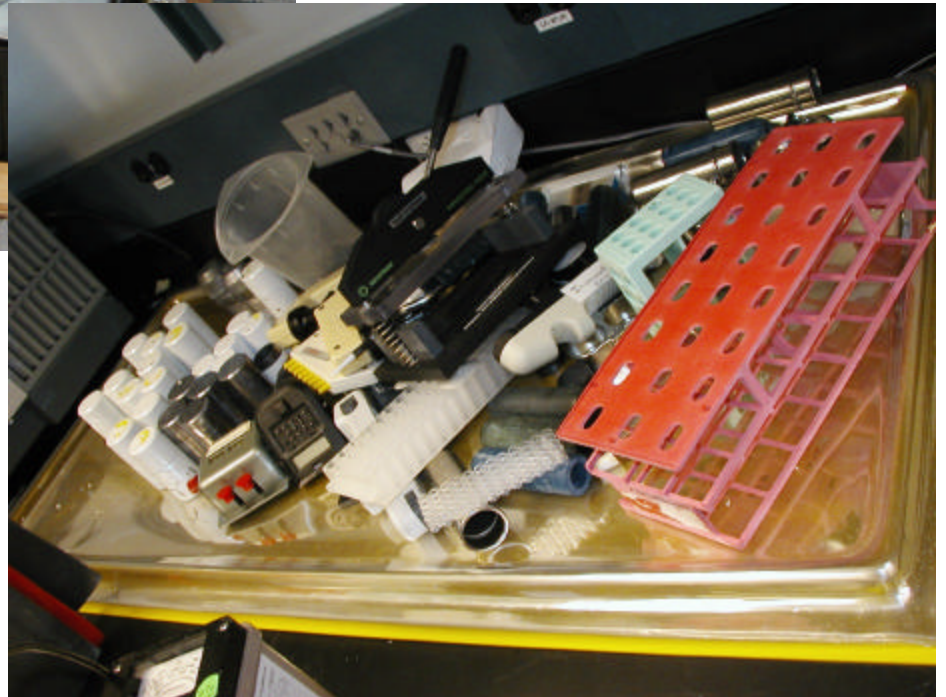




# Potentially Affected Equipment and Systems

- Fume hoods and biological safety cabinets
- Centrifuges and incubators
- Small and large refrigerators and freezers
- Sinks and drain lines
- Vacuum lines
- Exhaust ducts (HVAC and fume hood)
- Workbenches and drawers





# Facility History

- License limits:

H-3	1 Ci	C-14	0.5 Ci	P-32	0.1 Ci
P-33	0.1 Ci	S-35	0.1 Ci	Cl-36	0.01 Ci
Cr-51	0.2 Ci	I-125	0.02 Ci	Cs-137*	622 Ci

\* - Seal source in Gammacell 1000 Elite Irradiator

- Typical orders were 1 mCi to 5 mCi.
- Decay-in-storage for  $t_{1/2} < 120$  days.
- Documented spills.

# Scope of Work

- Prepare project documents.
  - Decommissioning Plan
  - Work Plan and Final Status Survey Plan
  - QAPP and SHASP
- Perform characterization-level survey.
  - Confirm site conditions
- Perform light decontamination and remove contaminated equipment.
- Perform Final Status Survey (FSS).
- Prepare radioactive waste for disposal.
- Prepare FSS Report.

# Decommissioning Plan

- Content and format based on U.S. NRC's NUREG-1727, "NMSS Decommissioning Standard Review Plan."
- The DP included:
  - A description of the site history and current radiological conditions,
  - A description of the planned decommissioning activities,
  - A description of the methods used to ensure protection of workers and the environment,
  - An updated detailed cost estimate for comparison against financial assurance.

# Decommissioning Plan

- Reviewed and approved by regulators.
  - Get early input on D&D methods and release criteria.
- Approval amended radioactive material license and authorized activities presented in the DP.
- Decommissioning Plans are not always required – check State and Federal guidance: NUREG 1757, “Consolidated NMSS Decommissioning Guidance,” Volume 1, “Decommissioning Process for Material Licensees” – Sept. 2002.

# Decommissioning Plan

- Release Criteria: regulatory, screening levels, dose-based approach (Derived Concentration Guideline Level - DCGL)
- Title 12 of the New York Industrial Code, Rule 38
  - Average – 5,000 dpm/100cm<sup>2</sup> total beta surface contamination
  - Maximum – 15,000 dpm/100cm<sup>2</sup> total beta surface contamination
  - Removable - 1,000 dpm/100cm<sup>2</sup> total beta surface contamination
- Alternative criteria for “inaccessible areas”
  - 200,000 dpm/100cm<sup>2</sup> total beta surface contamination
  - No more than 10% removable
- With non-dose-based criteria, verify through dose modeling or linear interpolation of screening values.

# Decommissioning Plan

- Addressing multiple isotopes of concern:
  - Use individual release criteria and apply the unity rule.
  - Model isotope with greatest dose impact and use gross activity criteria.
- Difficulties with H-3 detection:
  - Windowless H-3 detector
  - Base total activity on removable concentration measured in LSC (What is impact of assumption?)
  - ISO 7503-1, 1998, Evaluation of surface contamination, Beta emitters (maximum beta energy greater than 0.15 MeV) and alpha emitters.

# Work Plan

- On-site implementation document based on DP.
- Did not require regulatory approval.
- Provided specifics of on-site activities including waste management, surveys, and instrumentation.
- Incorporated the FSS Plan (MARSSIM-based).
  - Defines the survey units and background reference areas
  - Area classifications (MARSSIM)
  - Survey types and coverage
  - Data Quality Objectives (DQO)

# Work Plan (DQOs)

- The DQOs applied to the FSS and were established prior to conducting the survey.
  - Statistical test null hypothesis ( $H_0$ ): The residual activity in the survey unit exceed the release criterion.
  - Type I ( $\alpha$ ) and Type II ( $\beta$ ) decision error probabilities for the statistical test and for determining the number of fix-point measurements will be 5%.
  - For fixed-point, scan, and removable contamination measurements, the minimum detectable concentration will be less than 50% of the applicable release criterion.

# On-Site Activities

- Site mobilization and general employee preparation
  - Established field office, equipment staging area, and counting room
  - Established radiological control points
  - Client provided site-specific H&S training and site tour
- Survey of removable equipment
  - Same release criteria
- Decontaminate or dispose of as radioactive waste?

# On-Site Activities

Refrigerator	3,349 dpm/100cm <sup>2</sup> removable C-14	Disposed of as LLRW
Forceps and pen	>5,000 dpm/100cm <sup>2</sup> average beta	Disposed of as LLRW
Cell harvester	47,781 dpm/100cm <sup>2</sup> removable H-3	Decontaminated

# Final Status Survey

- Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) – a guidance, not a regulation
- Used MARSSIM for basis of FSS (not 100%)
- Regulatory imposed release criteria with alternatives proposed in DP
- Isotopes of concern: H-3, C-14, Cl-36 (dose driver)
- Isotopes of no concern: P-32, P-33, S-32, Cr-51, I-125
  - Short half-lives and known receipt dates and amounts
- Scans, fixed-point, and removable contamination surveys ( $\beta$ )
- Data analysis and conclusions

# Final Status Survey

- Survey unit classifications (MARSSIM+)
  - Class 1: limited to 100 m<sup>2</sup>; 100% scan; systematic fixed-point measurements; removable contamination measurement every square meter (H-3)
  - Class 2: limited to 1,000 m<sup>2</sup>; 10% scan, systematic fixed-point measurements, removable contamination measurements at fixed-point locations
  - Class 3: judgmental scans, random fixed point measurements; removable contamination measurements at fixed-point locations
- Two background reference areas because of construction materials

# Final Status Survey

- Class 1 Survey Units (4)
  - Floor and lower wall (< 6 m) of research laboratory (1)
  - Floor and lower wall of Immunology Rooms (2)
  - Floor and lower wall of waste decay/storage room (1)
- Class 2 Survey Units (2)
  - Floor of hallways adjacent to Class 1 areas
- Class 3 Survey Units (6)
  - Lower walls of hallways and upper walls (> 6 m) and ceilings in Class 1 areas
- Instruments: gas-proportional detectors (126 cm<sup>2</sup> and 582 cm<sup>2</sup>) and Beckman LS 6500 LSC

# Final Status Survey

- Determining the number of fixed-point survey measurements for each survey unit (MARSSIM)
- Necessary parameters:
  - Expected standard deviation of survey data ( $\sigma$ ) – determined during characterization surveys
  - The width of the statistical “Gray Region” ( $\Delta$ ) –  $\frac{1}{2}$  the release criteria
  - A tabulated probability value (Pr) based on  $\Delta/\sigma$  – as  $\Delta/\sigma$  approaches 4.0, Pr approaches 1
  - The “Z statistics” based on the acceptable decision error rates  $\alpha$  and  $\beta$ .

# Final Status Survey

$$N = \frac{(Z_{1-a} + Z_{1-b})^2}{3(\text{Pr} - 0.5)^2}$$

$$N = \frac{(1.645 + 1.645)^2}{3(1.0 - 0.5)^2} = 14.43$$

- N is the combined number of background reference area (BRA) AND survey unit (SU) data points
- To assure enough data points, N was increased by 20% and rounded up to the next even integer (18)
- Therefore, a minimum of 9 systematic fixed-point survey locations area are required in each BRA and SU

# Final Status Survey

- Class 1 and Class 2 have the same number of fixed-point measurement locations
- Random start triangular grid pattern for total beta fixed-point measurements (do not measure H-3)
- 1-meter square grid pattern for H-3 measurements (smears) – no direct H-3 measurements

# FSS Directs and Scan Locations:



# Grid Spacing:

$$L = \sqrt{\frac{A}{0.866n}}$$

where  $A = 75 \text{ m}^2$   
 $n = 9 = 3.10 \text{ m}$

$$C = 0.866L = 2.69 \text{ m}$$

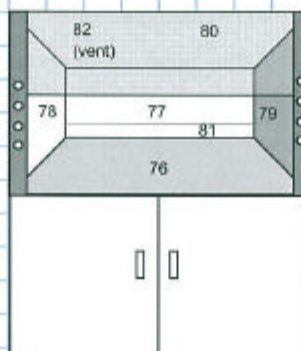
# Coordinates:

n	X	Y
1	4.5	2 (Random Start)
2	1.4	2
3	2.9	4.7
4	6.1	4.7
5	4.5	7.4
6	1.4	7.4
7	2.9	10
8	6.1	10
9	4.5	13

# Smear Locations:

		73	74	75		
		70	71	72		
63	64	65	66	67	68	69
56	57	58	59	60	61	62
49	50	51	52	53	54	55
42	43	44	45	46	47	48
35	36	37	38	39	40	41
28	29	30	31	32	33	34
21	22	23	24	25	26	27
14	15	16	17	18	19	20
7	8	9	10	11	12	13
		4	5	6		
		1	2	3		

# Hood Smears:



# Additional Smears:

83	Sink
84	Sink Trap
85-101	Misc. Items
102-104	Vacuum Lines
105-106	Ceiling
107-108	Upper Walls

# Legend:

	= 1 m <sup>2</sup>
	= Floor
	= Scan area boundary
	N

# Final Status Survey

- Fixed-Point MDCs ranged from 346 to 483 dpm/100 cm<sup>2</sup> (NUREG 1507 and MARSSIM).
- Scan MDCs ranged from 870 to 953 dpm/100 cm<sup>2</sup> (NUREG 1507 and MARSSIM).
  - $\epsilon_i$  for C-14 and  $\epsilon_s$  for low-energy  $\beta = 0.25$
- Many uncertainties not addressed.
- LSC MDCs: 32 to 49 dpm/100 cm<sup>2</sup> for H-3 and 17 to 20 dpm/100 cm<sup>2</sup> for C-14.

# Final Status Survey Report

- FSS fixed-point measurements – 82
- FSS smears – 246
- Additional fixed-point measurements – 15
- Additional smears – 62
- Maximum fixed-point: 973 dpm/100 cm<sup>2</sup> net  $\beta$  activity
- Maximum removable C-14: 117 dpm/100 cm<sup>2</sup>
- Maximum removable H-3: 287 dpm/100 cm<sup>2</sup>  
(2,870 dpm/100 cm<sup>2</sup> total H-3)

# Final Status Survey Report

- Provided net activity in dpm/100 cm<sup>2</sup> for all data (including negative values).
- If  $< \text{MDC}$ , reported as “ $< \text{MDC}$ .”
- If  $> \text{MDC}$ , reported net activity with an error rate (+/-) equal to the 1.96 x the standard deviation of the net count rate (MARSSIM).
- Other errors not propagated.

# Final Status Survey Report

- All scan data < release criteria
- All removable concentrations < release criteria
- MARSSIM direct comparison for fixed-point measurements – no Wilcoxon Rank Sum test needed
  - The difference in the smallest reference area measurement and the largest survey unit measurement is less than the release criterion
  - Held true for each survey unit
- All additional measurements < release criteria

# Project Summary

- Problems with H-3.
- Regulatory imposed total activity release criteria (vs. isotope-specific DCGLs).
- Alternative release criteria.
- Dose modeling.
- Instrumentation.
- Non-FSS measurements.
- No statistical tests needed.

# What to Think About for Your Decommissioning Project

- Do you need a Decommissioning Plan?
- Do you need Financial Assurance?
- A well-run laboratory/facility will likely result in an easy decommissioning.
- Well maintained records make for easy planning (when in doubt, file it away).
- Try to expect the unexpected (pipes and ducts do leak).

# What to Think About for Your Decommissioning Project

- Expert audits and advice can help keep you out of trouble and prepare for a successful decommissioning.
- No regulatory trouble  $\neq$  great program.
- Programs need updating to comply with changing regulations and guidance.
- Think about tomorrow today!

# Thoughts to Ponder from Albert Einstein

“The world is a dangerous place, not because of those who do evil, but because of those who look on and do nothing.”

“Problems cannot be solved at the same level of awareness that created them.”

“The secret to creativity is knowing how to hide your sources.”